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Paper 3: Petroleum Engineering: A collaboration between Academia and Industry

Hassan G. Mohamed [†‡], Fianu John[†], Malakooti Reza[†], Salazar Pablo[†], Kenomore Michael[†], Gharavi Amir[†]

† Petroleum Engineering, School of Energy and Electronic Engineering (SENE), University of Portsmouth, Anglesea Building A0.24.6, Anglesea Road Portsmouth PO1 3DJ

‡ Mohamed.hassan@port.ac.uk

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ABSTRACT

Petroleum Engineering remains an important area of study in our world and would continue to do so for the foreseeable future even with the advent of renewable energy and drive towards a more sustainable energy source. With this in mind, maximising the relationship that currently exist between the academia and industry is very important in order to produce the next generation of petroleum experts capable of providing innovation and change to drive this sector towards meeting the energy demands of the world. This paper provides a reflective analysis on the processes needed by both academia and industry to ensure they both work towards empowering future petroleum engineers to maximise the opportunities within this sector. By reviewing the academic curriculum and skills needed by petroleum engineers and also examining the limitations currently existing in the relationship between the oil and gas industry and academics, the paper offers ways by which a mutually beneficial relationship could be achieved.

INTRODUCTION

"Petroleum engineers make the world run." This proud quote, is extracted from the Society of Petroleum Engineers' website indicates how highly regarded a career in Petroleum Engineering is considered. This means that, it is very important for the educational process to work effectively to prepare the next generation of engineers to fulfil the industry needs.

As Petroleum Engineering completes a century in the academic realms, the rapid evolution of the petroleum industry and its technology has necessitated a concurrent change in the Petroleum Engineering education process. Whereas in the past, oil industry employers expected recent graduates to be competent 'plug-and-chug' engineers who would immediately contribute and fit into the daily work environment, modern day employers have additional requirements. They still want technically competent engineers with a solid understanding of the various industry technologies, but are also asking for more.

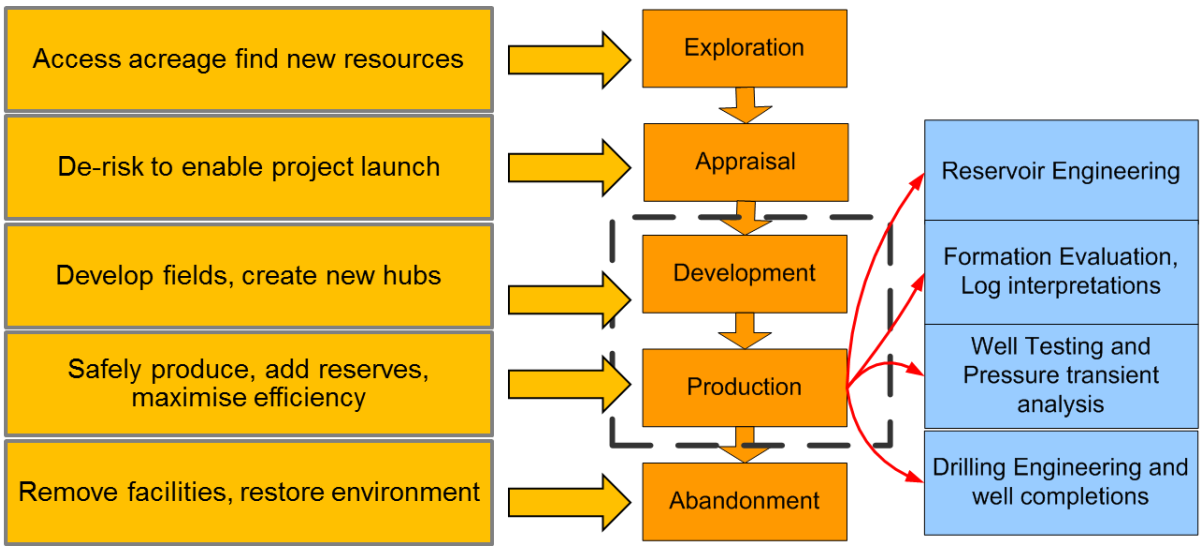
Educating and preparing engineers in general for the 21st Century requires adequate changes in the style of teaching and demonstrating knowledge, concepts and their application under complex conditions. The Energy industry is undergoing fundamental changes globally, coupled with the change in higher education landscape and funding, requiring a transformation in the classroom in order to prepare future engineers for contemporary issues in all aspects of oil and gas industry, especially exploration and production. Experience has shown that traditional teaching through lecturing generally results in students acquiring/ remembering less than 50% of the information delivered in the lecture (Cunha, 2004). Several factors contribute to such ineffective teaching/learning method. In this paper examinations and analysis of these factors are discussed to offer some tools to engineering professors who wish to become better teachers and to university administrators who wish to improve the quality of Petroleum Engineering teaching.

LITERATURE REVIEW

Petroleum Engineering as defined by University of Texas, a leading institute in petroleum, is a combination of innovation, exploration and expansion. that provides the major fuel for the world and the building blocks for every other profession to effectively carry out its work. University of Portsmouth, another leading institute, defines Petroleum Engineering as an engineering discipline concerned with mainly subsurface activities related to the production of hydrocarbon with the application of "engineering" to the exploration, drilling and production of oil & gas. Petroleum Engineering is associated with the "UPSTREAM" sector of

the oil & gas industry and is underpinned by the extraction of hydrocarbon whiles maximising oil and gas recovery at minimum cost in a safe way as highlighted in Figure 1.

Figure 1 Various disciplines within Petroleum Engineering sector



In any discussion of Petroleum Engineering Education, many questions arise concerning the best procedure to pursue and the best curriculum to follow in order that the young graduate may be as well-equipped as possible to enter the petroleum industry in an engineering capacity. It is clear that what may seem to be the best curriculum in Petroleum Engineering today may not be the best course of study for the future. Education in Petroleum Engineering is relatively new, and considerable evolution has been witnessed since the establishment of the first department at the University of Pittsburgh in 1912 (Cunha, 2004). The needs of the industry and the development of engineers to meet the changing order of events will dictate the relative emphasis which must be placed upon the so-called fundamentals and their application in the specialized course.

AIM AND OBJECTIVES

This paper seeks to examine the key relationship between academia and industry and to revaluate the ways by which each player could help enhance petroleum engineering. It also Reflects on the best practices within the academia and how they can improve the standard of tuition in petroleum engineering to ensure students are able to maximise their potential.

DISCUSSION

Petroleum Engineering Skills

The rapid evolution of the petroleum industry and its technology has necessitated a concurrent change in the Petroleum Engineering education process. In the past oil industry employers expected recent graduates to be competent 'plug-and-chug' engineers who would immediately contribute and fit into the daily work environment, Modern day employers have additional requirements. They still want technically competent engineers with a solid understanding of the various industry technologies, but are also asking for more. Knowledgeable, informed, intellectually curious, responsible, self-aware and self-motivated, independent learners set for success future careers are listed as the hallmarks of a graduate for Petroleum Engineering roles. Basic skills for a petroleum engineer, besides mastering fundamentals of mathematics, physics and chemistry, will include:

- Geology;
- Well drilling & completion technology;
- Formation evaluation;
- Oil and gas production technology;
- Properties of reservoir rocks;
- Properties of reservoir fluids;
- Fluid flow in porous media;
- Well testing analysis
- Reservoir performance prediction
- Enhanced oil recovery techniques
- Field economic analysis

Curriculum and Graduate attribute

Petroleum Engineering courses must include certain attributes in order to meet the demands of employers when assessing the skills of graduates. The curriculum must include the following points in it design for cradle to Job cycle as detailed in figure 2.

- Have a critical and reflective knowledge and understanding of their subject, with both the ability and readiness to question its principles, practices and boundaries.
- Think independently, analytically and creatively, and engage imaginatively with new areas of investigation within and across discipline boundaries.

- Be able to synthesise new and existing knowledge to generate ideas and develop creative solutions of benefit to the economy and society.
- Be intellectually curious, embrace challenges and seize opportunities for development.
- Be able to locate, access and critically engage with information, using current and emerging digital technologies.
- Be informed citizens, with a sense of responsibility allied to a commitment to ethical practice and social justice issues, such as equality, respect and sustainability.
- Be effective team players, able to provide leadership and to support the success of others.
- Be able to communicate clearly and effectively, in a range of forms and to different audiences.
- Have an enterprising spirit, bringing innovation and productivity to the groups and communities to which they belong.
- Be able to work in a range of environments, responding positively to new situations by being aware, flexible, adaptable and realistic in their expectations.
- Be proactive in recognising and addressing personal development needs, and able to make informed career decisions

Figure 2 Curriculum attributes

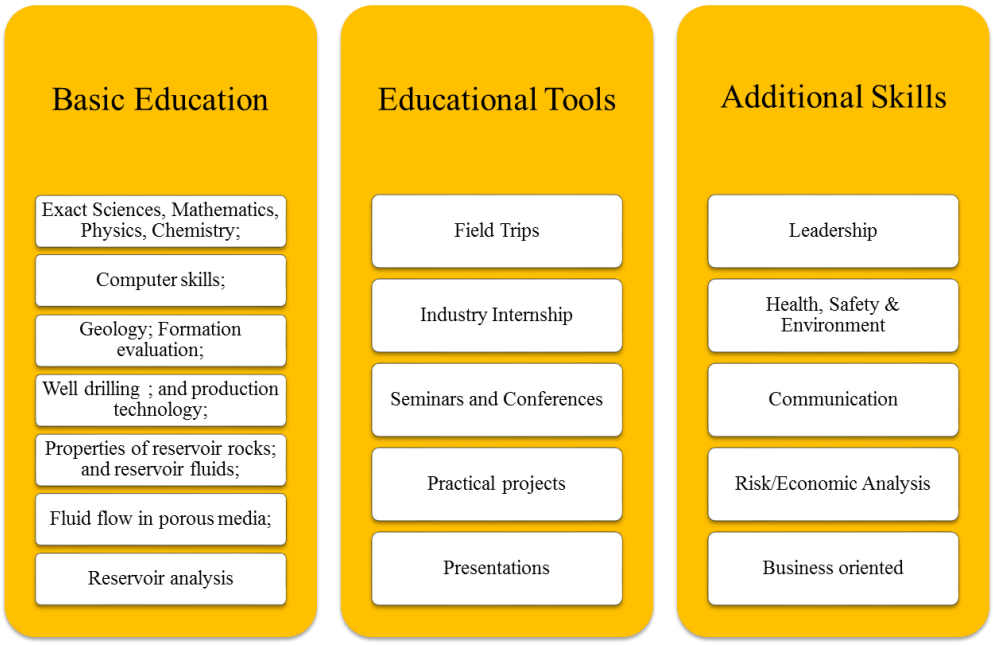


Figure 3 Characteristics of an Ideal Petroleum Engineering Graduate

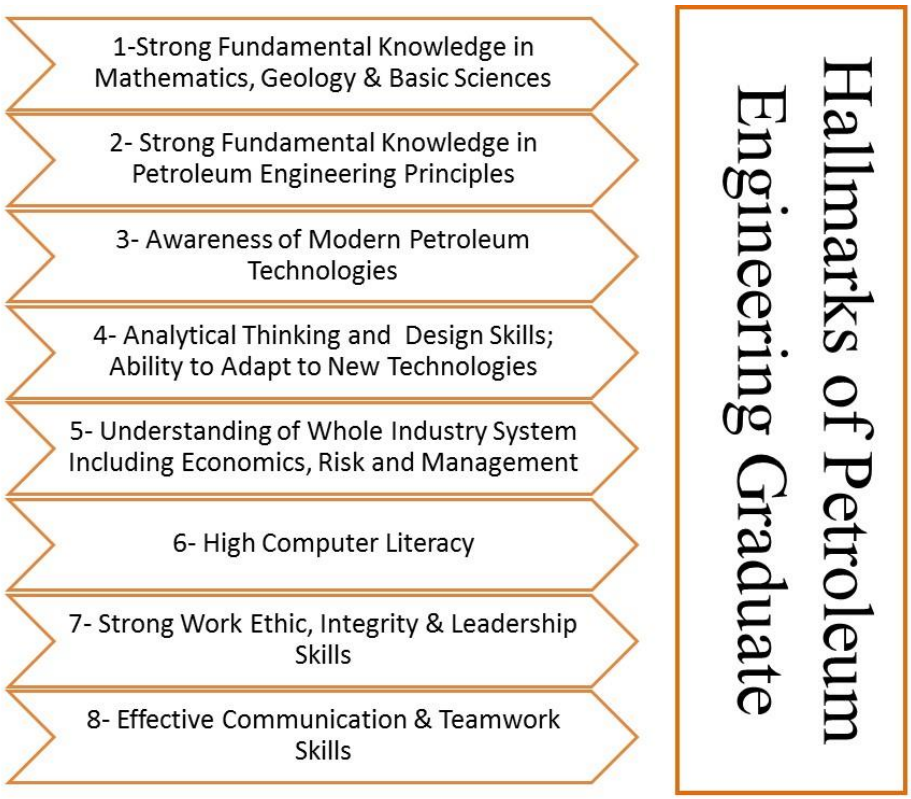


Figure 3 shows the characteristics of an ideal Petroleum Engineering student. It is probably unrealistic to expect to find the aforesaid set of skills on a recent graduate. However, as a goal, Petroleum Engineering education should provide the students with the means to use their technical background and personal qualification to acquire those skills.

Faculty and Teaching

The transformation of empirical knowledge into practice through a rigorous day to day problem solving activity that encompasses intuitive, reflective and moral perspectives of action, allows teachers to enact professional practice and enables tacit understanding and constructing from our own patterns of action. Also, this routine reflection on previous experiences, combined with technical and ethical qualities, brings professional knowledge into decision making in problematic, troubling and uncertain situations that can be reframed into different situations with a new meaning (Hoyle & John, 1995). Professional teachers in Petroleum Engineering must have and create social, industrial and educational impact, alongside other elements involved in professional practice such as autonomy to act and

judgements in the best interest of students, responsibility and accountability, their main focus is preparing the next generation of petroleum engineers capable to use new technologies and more qualified in innovating directions in management of oil and gas projects (Hoyle & John, 1995). Delivering high class teaching is paramount to deploy knowledge in complex and uniquely distinct classroom settings, and requires a clear understating of classroom practice along with highly skilled expertise and high quality, uninterrupted and solid engagement with students. The use and the development of research to assess and critique own practice combined with peer's observations is a good route to acquiring mastery in the classroom to improve practice (Furlong, 2013).

An important aspect of our own development, as members of the Petroleum Engineering faculty, is related to the development of our ability to understand situations and dilemmas that can lead to changes in our working relationships and professional practice. This development is not only an academic exercise to enrich our own particular subject knowledge, also encompasses adapting a critical and reflective approach into our practice to further develop competence and ultimately to crave our professional identity as faculty (Brock, 2015.).

Teaching Petroleum Engineering is not only about using endless, and sometimes, boring and disengaging presentations just to pass complex concepts and specific subject knowledge to students; but instead is about integrating theory and practice by tailoring theoretical and research-based knowledge to fit specific practical situations through a perspective more firmly rooted in the realities of practice, in which the professional knowledge base offers insights but no direct lines of actions for dealing with specific practice situations, which is the essence of reflective practice(Thompson & Pascal, 2012).

So aside from the curriculum content, a critical look at teaching methodology must be reviewed. Teaching courses using the same way that is taught over 50 years ago with the exceptions of replacing the black board and chalk with PowerPoint presentations is not a good way. Educational and teaching methods are being influenced by new emerging technologies (software, on-line quiz, 3D animations, documentary videos, etc.) and the content of Petroleum Engineering programmes needs to dynamically adapt to the world of the millennium or face the risk of extinction. Petroleum Engineering faculty as well as professionals in the industry have been challenged to "learn to listen first, understand issues and concerns, then respond by sharing facts, doing additional research, reporting progress and continuously improving" (Smith et al., 2017).

Professional Petroleum Engineering faculty should be autonomous knowledgeable practitioners with moral, social and environmental responsibility accountable for the development and improvement of their academic and professional knowledge and are fully aware of student's learning needs and industry's skills necessities.

The teaching model of class room delivery of course materials and testing learning outcomes by exams must be reflected upon and more practical elements and problem based learning provided.

Many academic are teaching their courses in complete isolation from others with no linkage of the material taught in relation to other courses, to the overall objectives of the degree, and most importantly to practical and field applications.

- Young and mid-career faculty, who is in line for promotion, are always more busy and focused on research. Young faculty members are usually unable to relate the courses they teach to practical and field applications.
- Senior faculty, professors, on the other hand usually have many graduate students, funded research projects, administration and management paperwork made them far removed from undergraduate students interactions beyond lecture time.
- Retired industrialist who are willing to spend time with student on war stories but disconnected from curriculum requirement.

Industry Collaboration

The recent downturn in the oil & gas industry has forced many companies to work on developing their internal systems and corporate social responsibility. This has led to the number of jobs being reduced and reorganization of the existing staff is being undertaken to improve efficiency. The challenge is further raised when a balancing act needs to be played to manage the availability of experienced staff and the less experienced young professionals to mitigate everyday complex challenges. To avoid such situations in the future some steps need to be taken now. It is clear that steps taken today may not provide us with an instant solution but would protect the industry against the unseen challenges of the future. Questions need to be raised on the finding the right solutions to the challenges faced by the industry as well as how those challenges could be overcome.

The solution is obvious from the academic side and involves embarking on less well-known ways to collaborate with industry. The suggestions put forth here may not attribute a lot in short term, but in the long term will definitely contribute in solving few of the above

challenges. The continuous training of professionals with latest technology is always the best solution for the short term. However, for the long term the most suitable way will be to collaborate with universities, the very place from where the upcoming talent is born and honed for their skill set development. Furthermore this will provide the universities with an additional input to enhance their courses and align it better with industrial requirements. The main categories where companies can contribute and gain new talent can be grouped under the following:

- KTP (knowledge transfer partnership)
- MReS (Masters of Research)
- Contribution to courses (PhDs, MSc & M/BEng) with Industrial Projects and Data
- Internships
- Software packages, equipment donations and infrastructure fieldtrips

Knowledge Transfer Partnership (KTP) is a part government-funded programme to encourage collaboration between businesses and universities in the United Kingdom. KTP was launched in 2003 and the programme is funded by 17 public sector organisations. There are approximately 1,000 concurrent programmes at any one point in time and KTP works with over 140 universities, colleges, and research organisations across the UK. A (KTP) is a three-way project between an academic, a business and a recently qualified person (known as the Associate).

The aim of each KTP programme is to help businesses improve their competitiveness and productivity through the better use of skills, knowledge, technology and innovation. As a part-government funded programme, a company entering into a KTP programme contributes between 33-50 % of the project cost, with the government contributing to the rest. The average annual project costs are approximately £60,000. This package includes the associate's salary, travel budget, personal development budget, academic input, expertise, and administrative support.

KTP provides leading academics with the opportunity to:

- Apply knowledge and expertise to important businesses problems
- Develop business relevant teaching and research material

- Identify new research themes in undergraduate and post-graduate projects
- Publish high quality journal and conference papers
- Gain an improved understanding of business requirements and operations
- Participate in rewarding and ongoing collaboration with innovative businesses
- Supervise and act as mentors for past graduates working on business based projects

What can KTP offer your business?

- Access to qualified people to spearhead new projects
- Access to experts who can help take your business forward
- Develop innovative solutions to help your business grow
- Increase your competitive advantage
- Improve your performance/business operations
- Increase profitability

Master of Research is a Part-time/full time degree that provides an excellent opportunity for professionals to undertake research and is increasingly popular within a number of the Russell Group Universities. Professionals have the opportunity to focus their research interests on one or two areas, allowing them to become an expert in specific subject knowledge. It also provides the environment to translate their findings into research related outputs. Such research can also be undertaken by professionals based on their area of expertise to gain a degree for their career enhancement including such activities as: preparation of peer review publications, critical reviews, grant applications, conference presentations or intellectual property submission.

Contribution to courses (PhDs, MSc & M/BEng) with industrial rojects could be one of the most proactive ways of starting industry and university collaboration. It is a direct collaboration where a company can engage with a student while performing a final year or a master's project. It can be a literature research based project or practical one, where any sensitive data can be protected with confidentiality agreements. It is win-win collaboration where skills, innovation and enthusiasm of a student can be assessed while performing their project. Through this collaboration students can develop business acumen and improve professionalism, while working on a project with real data that can maximise challenges and enhances the learning experience.

The industry and university students always value internships greatly. It provides an opportunity for the student to move from university-based theoretical knowledge to practical application. Further, it introduces students to the fast paced challenging professional environment. This is an on-going practice that is utilised by a number of organisations. In the past few years we have seen a steady decline in the number of internships being offered. It is understandable considering the market volatility of the past few years followed by a sharp decline in the oil prices making things difficult.

However, a few innovative ideas can really help to boost enthusiasm. An attractive alternate could be something similar to the “Shell Eco-marathon competition”, where teams of students from around the world design and test ultra-energy-efficient vehicles. The event also sparks debate on future mobility challenges and inspires young engineers to push the boundaries of fuel efficiency. Another example is “ European Association of Geoscientists and Engineers (EAGE) Challenge” where multi-disciplinary teams of student are invited to characterise a real hydrocarbon field provided by a world-recognised oil & gas company and propose most economic development strategies. This event takes place every year during the annual EAGE Conference & Exhibition.

A similar competition could be organised with the help of professional bodies. The competition could either be themed around a subject area of interests (e.g. reservoir modelling, EOR applications, shale gas recovery) or be an open challenge that industry can support through their expert professionals or use of old datasets.

Additionally, most bachelor’s courses offer a sandwich degree where a student can take a year out to work within the industry and achieve vital experience. This can help prepare graduates for the industry and provide hands on experience. Provision of advanced laboratory set-ups is also crucial for successfully delivering the next generation of petroleum engineers. Advanced computer labs with all the latest industry standard software packages allows faculty to integrate them into the course through assessment or demonstrations. Additionally, software packages contribute a great deal to research and innovations. Also, visualisation of field equipment (e.g. Drilling Pipe, Bit, Logging Tools, Production tools) enhance the learning experience of the students. Though doing all they can, universities find it difficult to purchase all the equipment they would like. In such cases the industry can definitely contribute a great deal and enhance the learning experience of the students by donating used equipment that can be displayed in university laboratories.

Providing students with access to field sites will help them visualize the operation and interact with field professionals. Such interaction brings them to the reality of production

technology and elevates their learning experience. There is a general belief that no industry can survive unless it succeeds in inspiring future generations to join its ranks.

CONCLUSIONS & RECOMMENDATIONS

Petroleum Engineering is an important area of study that requires innovative and collaborated effort from both industry and academia to ensure that the best practices are taught and also students are able to maximise their learning in order to be highly employable in this high technology industry. New teaching methodologies which promotes creativity, independent thinking and problem solving should be part of the curriculum that enhances the skills of student. Collaboration is key to the success of Petroleum Engineering especially between the academia and industry where investment is needed to promote tailored courses that would suit the needs of the industry. Utilising internship opportunities for young faculty members and students to give field experience would go a long way in promoting relationships that could be useful for solving the industry problems in the near future.

To be able to address the current challenges faced by both academia and industry in promoting petroleum engineering as well as ensuring students are well equipped to take on the challenges within this sector, several considerations would have to be made among which are

- Courses should be taught in a way that relates units to each other and emphasizes their relevance to practical applications.
- Find ways that make students more proactive and engaged in learning and arriving at desired results on their own, we need to stop spoon feeding knowledge and information.
- Effort should be made towards the goal of attracting more and better prepared students to PE.
- Sharing field data and thus allowing more realistic examples and field cases to be presented to students, to enhance quality of PE courses, and better prepare the students for the oil business environment.
- Without compromising traditional science education, regarded as fundamental for engineering students, emphasis should also be placed on a broad range of information related to the oil business and the global economy. Be aware of risk, ethics, health, safety and environment.
- Establishment of channels, allowing free communication between Industry and Academia, must be a priority in order to achieve efficient and up to date courses.

- Industry feedback is important and certainly PE education for the next 20 years will be closely related to the future reserved to the industry.
- Align industry funded graduate research with the immediate needs of the industry, leading to close collaboration with the industry and the service sector.
- Establish a university-industry R&D conference, promote private one-on-one industry-university dialogue, and continue with the conventional university consortia

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